US-PAT-NO: 6275614

DOCUMENT-IDENTIFIER: US 6275614 B1
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TITLE: Method and apparatus for block classification and adaptive bit allocation

DATE-ISSUED: August 14, 2001

US-CL-CURRENT: 382/224, 348/384.1 , 375/240.11 , 382/115 , 382/118 , 382/133 , 382/165 , 382/238

APPL-NO: 09/ 295878

DATE FILED: April 21, 1999

PARENT-CASE:

This application claims the benefit of U.S. Provisional Application No. 60/090,813 filed Jun. 26, 1998, which is herein incorporated by reference.

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Drawing Description Text - DRTX (6):
FIG. 4 illustrates a flowchart of a method for applying importance information to adaptively **adjust the quantization level** or scale for a block;

Detailed Description Text - DETX (4):

The apparatus 100 is an encoder or a portion of a more complex block-based motion compensated coding system. The apparatus 100 comprises a preprocessing module 120, a motion estimation module 140, a motion compensation module 150, a rate control module 130, a transform module, (e.g., a discrete cosine transform (DCT) module or a **wavelet** transform module) 160, a quantization module (Q) 170, a coder, (e.g., a variable length coding (VLC) module) 180, a buffer 190, an inverse quantization module (Q.sup.-1) 175, an inverse transform module (e.g., an inverse DCT module or an inverse **wavelet** transform) 165, a subtractor 115 and a summer 155. Although the encoder 100 comprises a plurality of modules, those skilled in the art will realize that the functions performed by the various modules are not required to be isolated into separate modules as shown in FIG. 1. For example, the set of modules comprising the motion compensation module 150, inverse quantization module 175 and inverse DCT module 165 is generally known as an "embedded decoder".

Detailed Description Text - DETX (10):

The predictive residual signal is passed to a transform module, e.g., a DCT module 160 or a discrete **wavelet** transform (DWT). The DCT module then applies a forward discrete cosine transform process to each block of the predictive residual signal to produce a set of eight (8) by eight (8) block of DCT

coefficients.

Detailed Description Text - DETX (15):

Namely, in common image coding standards, **changing the quantization parameter** or scale, Q, controls the quality in various parts of the image. Thus, one can code different areas of the frame with different Qs in order to reflect the difference in importance of the various areas to the viewer. In the present invention, a method is presented that varies the Q across the frame such that a tight control is maintained on the bits allocated to the frame, and the Qs reflect the relative importance of the blocks. A detailed description of the present adaptive bit allocation method is provided below.

Detailed Description Text - DETX (50):

To summarize, FIG. 4 illustrates a flowchart of a method 400 for applying the importance information to adaptively **adjust the quantization level** or scale for a block. Method 400 starts in step 405 and proceeds to step 410, where method 400 selects a first block from a frame for bit allocation.

US-PAT-NO: 5952943

DOCUMENT-IDENTIFIER: US 5952943 A

TITLE: Encoding image data for decode rate control

DATE-ISSUED: September 14, 1999

US-CL-CURRENT: 341/50, 709/247

APPL-NO: 08/ 729448

DATE FILED: October 11, 1996

PARENT-CASE:

CROSS-REFERENCES TO RELATED APPLICATIONS

This nonprovisional U.S. national application, filed under 35 U.S.C. .sctn. 111(a), claims, under 35 U.S.C. .sctn. 119(e)(1), the benefit of the filing date of provisional U.S. national application no. 60/010,518, filed under 35 U.S.C. .sctn. 111(b) on Jan. 24, 1996 as attorney docket no. 366431-136P, the teachings of which are incorporated herein by reference. This application is also a continuation-in-part of U.S. patent application Ser. No. 08/558,258, filed Nov. 13, 1995 as attorney docket no. 366431-022 ("the '1022 application"), the teachings of which are incorporated herein by reference. This application is also a continuation-in-part of U.S. patent

application Ser. No. 08/537,249, now U.S. Pat. No. 5,748,903, filed Sep. 29, 1995. This application is also related to U.S. patent application Ser. No. 08/568,247, filed Dec. 6, 1995 as attorney docket no. 366431-096 ("the '1096 application") and to U.S. patent application Ser. No. 08/671,382, filed Jun. 27, 1996 as attorney docket no. 366431-125 ("the '1125 application"), the teachings of both of which are incorporated herein by reference.

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Detailed Description Text - DETX (22):

In one embodiment, compression processing for each frame begins by optionally applying a global transform to one or more of the component planes to decompose the component planes into a plurality of bands (step 302). For example, a forward **wavelet** transform may be applied to the Y-component plane to globally decompose (i.e., transform) the Y-data into four separate bands of data, thereby producing a total of six bands of data for each frame: four Y-component bands, one U-component band, and one V-component band. FIG. 4 shows a graphical representation of the six band sequences. One forward **wavelet** transform is described in further detail in the '1022 application in the section entitled "**Wavelet** Transform." Those skilled in the art will understand that other transforms and other decomposition schemes may be applied

in other embodiments of the present invention.

Detailed Description Text - DETX (23):

For purposes of this specification, the four Y-component bands are designated Band Y0, Band Y1, Band Y2, and Band Y3. The subsanpled U-component plane (which is not **wavelet** transformed) is designated Band U, and the subsampled V-component plane (which is also not **wavelet** transformed) is designated Band V.

Detailed Description Text - DETX (25):

Referring now to FIG. 5, there is shown a block diagram of frame encoder 500 which implements the compression processing of FIG. 3, when the forward **wavelet** transform is applied to only the Y-component plane. Transform 502 applies a forward **wavelet** transform to the Y-component plane of each frame to generate Bands Y0-Y3 (step 302 of FIG. 3). Band encoders 504 encode the six bands of data (step 304 of FIG. 3) and bitstream generator 506 embeds the resulting encoded bands into the encoded video bitstream (step 306 of FIG. 3). In one embodiment, there is a single band encoder 504 that sequentially encodes the different bands.

Detailed Description Text - DETX (38):

Referring now to FIG. 7, there is shown a process flow diagram of the decompression processing implemented by host processor 208 of decode system 200

of FIG. 2 for each encoded frame of the encoded video bitstream, according to one embodiment of the present invention. Host processor 208 parses the encoded bands from the encoded video bitstream (step 702 of FIG. 7) and applies decode processing to each of the encoded bands (step 704). In the case where the Y-component plane was decomposed into four bands during encoding, an inverse transform is applied to the four decoded Y-component bands to generate the decoded Y-component plane (step 706). The decoded Y-component plane data are then processed with the decoded U- and V-component plane data to generate a decoded video image for display. One inverse transform is described in further detail in the '1022 application in the section entitled "**Wavelet** Transform."

Detailed Description Text - DETX (39):

Referring now to FIG. 8, there is shown a block diagram of frame decoder 800 which implements the decompression processing of FIG. 7. Bitstream parser 802 parses the embedded bitstream into the encoded band sequences (step 702 of FIG. 7). Band decoders 804 decode the bands of encoded data for each frame (step 704 of FIG. 7) and inverse **wavelet** transform 806 applies an inverse **wavelet** transform to the decoded Y-component bands to generate the decoded Y-component plane (step 706 of FIG. 7). In one embodiment, there is a single band decoder 804 that sequentially decodes the different encoded bands.

Detailed Description Text - DETX (69):
Global decomposition (i.e., forward **wavelet** transform): what if any components are to be decomposed and how many times (e.g., further decomposition of the Y0 band).

Detailed Description Text - DETX (73):
Quantization**: selection/change of quantization level (i.e., change of quantization table**).

US-PAT-NO: 6351491

DOCUMENT-IDENTIFIER: US 6351491 B1

TITLE: Apparatus and method for optimizing the rate control for multiscale entropy encoding

DATE-ISSUED: February 26, 2002

US-CL-CURRENT: 375/240.03, 382/239 , 382/240 , 382/248 , 382/251 , 382/252

APPL-NO: 09/ 594401

DATE FILED: June 15, 2000

PARENT-CASE:

This application claims the benefit of U.S. Provisional Application No. 60/140,545 filed Jun. 23, 1999, which is herein incorporated by reference.

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Detailed Description Text - DETX (5):

To illustrate, FIG. 4 is a schematic illustration of the dependency of zerotree based coding. In ZTE, each quantized **wavelet** coefficient is assigned one of four zerotree symbols: ZTR, VZTR, VAL and IZ. Assuming an image is decomposed into four **wavelet** decomposition layers,

layer-0, layer-1, layer-2
and layer-3, where layer 0 is the coarsest layer (i.e., closest to the DC
layer) and layer 3 is the finest layer. Let Q0, Q1, Q2 and Q3 be the
quantization parameters or scales for layer-0, -1, -2, and -3 respectively.
Then the change of Q2 value may affect the zerotree symbol assignment of nodes
in layer-1 and layer-0. Similarly, the change of Q1 value may affect the
zerotree symbol assignment of nodes in layer-0, but not layer-2. FIG. 4
illustrates such a scenario where without loss of generality, assuming that at
iteration i, all of nodes X in layer-0, Y in layer-1 and Z in layer-2 are
quantized to 0 with zerotree symbol ZTRs. At the next iteration i+1, Q2
decreases so that node Z is quantized to non-zero value (i.e., 4 in this case),
then node Z is marked as VZTR, then node Y will be marked as IZ since one of
its children is not zero. Similarly, node X is marked as IZ. From the above
scenario, it becomes clear that the **quantization parameter change** in a lower
layer affects the bitrate used in its upper layer since the statistics of
zerotree symbols are changed. The present rate control invention is capable of
addressing such dependency.